## Escaping the Losses from Trade: The Impact of Heterogeneity and Skill Acquisition

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### **Motivation**

#### o Important distributional consequences of trade

Autor, Dorn & Hanson (2013), Pierce & Schott (2016), Burstein & Vogel (2017),...

- Potential losses from greater import competition
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- o Several margins of adjustment to overcome initial losses
  - Regional migration

Caliendo, Dvorkin & Parro (2019), Dix-Carneiro & Kovak (2018), Lyon & Waugh (2019), ...

- Switching industries and/or occupations Dix-Carneiro (2014), Traiberman (2020), ...

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o Margin of adjustment for new generations of workers?

o Skill acquisition/college as a margin of adjustment

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- Two questions:
  - + Do trade shocks affect college decisions?
  - $+\,$  What are the welfare consequences in the short- and long-run?

- o Evidence: effects of trade shocks on college enrollment
  - $+\,$  Effects on labor market outcomes for college/non-college

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  - + Effects on labor market outcomes for college/non-college
- o Dynamic trade **model** with heterogeneous households
  - + Aiyagari-OLG structure with *costly education choice*
  - + Multi-region SOE model with HO-type comparative advantage
  - + Costly switching across local labor markets

#### What we find

- Evidence: trade shocks
  - + are more detrimental for less educated workers
  - + younger cohorts respond acquiring more education ... only in high-income families

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- Evidence: trade shocks
  - + are more detrimental for less educated workers
  - + younger cohorts respond acquiring more education ... only in high-income families
- o Model: trade openness induces
  - + Short-run:
    - Higher wage premium and increased college enrollment . . . for wealthy households
    - Uneven welfare gains/losses determined by region, sector, and wealth.
  - + Long-run:
    - All welfare gains and higher college enrollment
    - Endogenous skill acquisitions makes long-run welfare gains more equal

#### **Literature Review**

- o Trade shocks and labor market adjustment
  - Autor, Dorn & Hanson (2013), Pierce & Schott (2016), Artuç, Chaudhuri, & McLaren (2010), Dix-Carneiro (2014), Traiberman (2020), Caliendo, Dvorkin & Parro (2019),...
- o Macroeconomics and skill acquisition
  - Charles, Hurst & Notowidigdo (2016)
  - Abbott, Gallipoli, Meghir & Violante (2019), Daruich (2020)
  - Adao, Beraja & Pandalai-Nayar (2020)
- o Trade, human capital, and inequality
  - Findlay & Kierzkowski (1983), Blanchard & Willmann (2016), Danziger (2017), Ghose (2019)
  - Atkin (2016), Greenland & Lopestri (2016), Blanchard & Olney (2018)
  - Katz and Murphy (1992), Autor, Katz and Kearney (2008), Keane and Wolpin (1997), Huggett, Ventura and Yaron (2011)
  - Helpman et al. (2010, 2017), Antràs et al. (2017), Burstein et al. (2016), Burstein & Vogel (2017)
- o Heterogeneous-agents trade-spatial macro models
  - Lyon & Waugh (2018, 2019), Carroll & Hur (2019,2020), Giannone et al. (2020), Greeney (2020)

## Evidence

o **Import penetration** in region (market) r in period t

$$\Delta IPW_{rt} = \sum_{i} \frac{L_{rit}}{L_{rt}} \frac{\Delta M_{it}}{L_{it}}$$

*i*: sector,  $M_{it}$ : Chinese imports,  $L_{rit}$ : workers sector *i* and region *r*,

$$L_{rt} = \sum_i L_{rit}$$
, and  $L_{it} = \sum_r L_{rit}$ 

- o Data overview:
  - + 722 commuting zones (regions)
  - + Two waves
    - Period 1990-2000:  $\Delta IPW_{rt}$  Median: \$1,140, IQR: \$600
    - Period 2000-2007:  $\Delta IPW_{rt}$  Median: \$2,600, IQR: \$1,500

• Effect of *import competition* on variable  $y_{it}$ 

$$\Delta y_{rt} = \gamma_t + \beta \Delta IPW_{rt} + \delta X_{rt} + e_{rt}$$

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- + effect on different groups
  - working age 30-55 ightarrow by education levels
  - education decisions for ages 18-25

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o Instrument  $\Delta IPW_{it}$  by Chinese imports in other high-income countries

#### Effect on labor market opportunities: Income

. . . . . . . . . . .

$\Delta y_{rt}$ : log change in labor income by education, ages 30-55								
	All	High School	Some Coll	2-y program	Bachelor			
$\Delta IPW_{rt}$	$-0.92^{**}$							
	(0.40)							

20 55

Notes: "Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more; \*\*\* p < 1%, \*\* p < 5%, \*p < 10%

o A \$1,000 increase in imports

Δ.

+ Decreases average labor income by 0.92%

#### Effect on labor market opportunities: Income

	All	High School	Some Coll	2-y program	Bachelor
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- o A \$1,000 increase in imports
  - + Decreases average labor income by 0.92%
  - + Larger decline for less educated workers
  - + No effect for workers with bachelor degree or more

#### Effect on labor market opportunities: Employment

$\Delta y_{rt}$ : chang	e in fraction	of pop	employed	by	education,	ages 30-55	

	All	High School	Some Coll	2-y program	Bachelor
$\Delta IPW_{rt}$	$-0.73^{**}$				
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$\Delta IPW_{rt}$	$-0.73^{**}$	$-1.06^{***}$	$-0.46^{***}$		
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 $\Delta u_{\mu\nu}$  change in fraction of non-employed by education ages 30-55

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	(0.20)	(0.30)	(0.13)	(0.18)	(0.12)

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Notes: "Some Coll" are all individuals with some college, "2-y program" are those who graduated from a 2 year program, and "Bachelor" are those with a bachelor degree or more; \*\*\* p < 1%, \*\* p < 5%, \*p < 10%

- o A \$1,000 increase in imports
  - + Decreases average labor income by 73bps
  - + Larger decline for less educated workers
  - + Smallest effect for workers with bachelor degree or more

#### Effect on education: Dealing with migration

- o Individuals age 18-25 migrate often, especially to attend college
  - $\rightarrow~\approx 50\%$  of freshmen in colleges > 100 mi away from perm home (HERI at UCLA)
  - $\implies$  Two strategies to deal with migration:

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- Link to previous commuting zone → measure of migration 
   → Restrict to ages 18-25 currently in their first year of college
- 2. Consider individual level PSID data  $\rightarrow$  can follow individuals over time
  - $\rightarrow$  Restrict to high school graduates enrolled in college

$\Delta y_{rt}$ :	change	in	1st-year	college	enrollment	ages	18-25
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	$EnrolIment_t$	$Enrollment_{t+1}$
$\Delta IPW_{rt}$	$0.19^{**}$	
	(0.09)	
***		·

Notes: \*\*\*p < 1%, \*\*p < 5%, \*p < 10%

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	$EnrolIment_t$	$Enrollment_{t+1}$	
$\Delta IPW_{rt}$	$0.19^{**}$	$0.36^{*}$	
	(0.09)	(0.2)	
*** < 107 **		-	

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  - + Significantly strong delayed effect on enrollment of 36 bps

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- o A \$1,000 increase in imports
  - + Increases college enrollment by 19 bps
  - + Significantly strong delayed effect on enrollment of 36 bps
- o Similar results for high school completion in Greenland & Lopresti (2016)

#### Effect on education by wealth: ACS vs PSID

- + ACS counts college students as *new* households
  - observe last year commuting zone  $\rightarrow$  can test enrollment
  - cannot link to household's characteristics/wealth
- + PSID provides longitudinal data
  - can follow individuals over time
  - can link to family wealth and original CZ (restricted geocode data)
  - small sample, can use individual level regressions

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  - small sample, can use individual level regressions
- + Proxy wealth by income  $\rightarrow$  CPS treats college as temporarily away
  - can link to family income and original commuting zone
  - can use individual level regressions

Linear prob model on college enrollment,  $e_{nrt} \in \{0, 1\}$ 

$$e_{nrt} = \sum_{q} \beta^{q} \mathbb{I}_{\left\{Y_{h(n)rt} \in q\right\}} \Delta IPW_{rt} + \theta_{Y}Y_{h(n)rt} + \theta_{e}e_{h(n)rt}^{p} + \delta X_{rt} + u_{nrt}$$

+ Quartiles by households' wealth  $Y_{nrt}$ :

- groups: < 25%, 25% - 50%, 50% - 75%, > 75%

+ controls: family wealth + HH's head education + regional-level

#### Effect on education by Wealth level - PSID



College enrollment by wealth quartiles  $\beta^q$ 

o Enrollment increases for topwealth households, decreases for bottom-wealth.



- 1. Trade shocks detrimental labor market outcomes
  - $\rightarrow\,$  especially for less educated workers
- 2. Young individuals (18-25 and HS graduates) adjust by enrolling into college
- 3. Enrollment increase driven by high school graduates in richest households

# Model

#### Trade model with heterogeneous HHs and skill acquisition

 $\rightarrow$  SOE with multiple regions trading goods and assets within and across borders

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 $\rightarrow$  SOE with multiple regions trading goods and assets within and across borders

- + Technologies: two sectors, services and manufacturing
  - o Intermediate goods  $\rightarrow$  Tradable
    - Inputs: college workers & non-college workers
  - o Final goods  $\rightarrow$  Non-tradable
    - Inputs: domestic region-specific & imported intermediate goods
# Trade model with heterogeneous HHs and skill acquisition

 $\rightarrow$  SOE with multiple regions trading goods and assets within and across borders

- + Technologies: two sectors, services and manufacturing
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    - Inputs: college workers & non-college workers
  - o Final goods  $\rightarrow$  Non-tradable
    - Inputs: domestic region-specific & imported intermediate goods
- + Households/Workers: continuum & finitely-lived
  - o Education: one-time decision at age  $j=1 \rightarrow {\rm preference\ shock}$
  - o Sector-Region (LLM): switch at any age  $\rightarrow$  utility cost + preference shock
  - o Intervivos transfer to kid at age  $j = J_k \rightarrow$  bequest motive
  - o Idiosyncratic labor risk, save in bonds return  $r^*$ , retire at  $J_R$

#### Intermediate goods – tradable – sector i = s, m

$$\max_{L_{cri},L_{nri}} p_{ri} z_{ri} \left( \frac{\gamma_{ri} L_{cri}^{\frac{\sigma-1}{\sigma}} + (1-\gamma_{ri}) L_{nri}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} - w_{cri} L_{cri} - w_{nri} L_{nri}$$

+  $L_{cri}$  and  $L_{nri}$  denote college and non-college labor in region r and sector i

- $+ w_{cri}$  and  $w_{nri}$  denote college and non-college wages
- $+ z_{ri}$  sector productivity

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- $+ z_{ri}$  sector productivity

Key assumptions:

o college and non-college workers are substitute:  $\sigma > 1$ 

o Service is more intensive in college workers:  $\gamma_{rs} > \gamma_{rm}$  (Cravino and Sotelo, 2018)

Decline in manufacturing w.r.t. services  $\rightarrow$  lower demand for non-college w.r.t. college workers

#### Final goods – non-tradable – sector i = s, m

+ Technology: 
$$Q_{ri} = \left[\omega^{\frac{1}{\eta_i}} D_{ri}^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} (D_{ri}^*)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

 $\rightarrow D_i$  composite of domestic intermediates and  $D_i^*$  imported one

$$D_{ri} = \left(\sum_{r' \in \mathcal{R}} \alpha_{rr'}^{\frac{1}{\omega}} d_{rir'}^{\frac{\theta}{\theta-1}}\right)^{\frac{\theta-1}{\theta}}$$

+ Profits 
$$\max_{\{d_{rir'}\}_{r'}, D_{ri}^*} \{q_{ri}Q_{ri} - \sum_{r' \in \mathcal{R}} \tau_{rir'} p_{r'i} d_{rir'} - p_i^* \tau_i^* D_{ri}^* \}$$

$$\rightarrow$$
 price of final good  $q_{ri} = \left[\omega \bar{p}_{ri}^{1-\eta} + (1-\omega) \left(\tau_i^* p_i^*\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}$ 

 $\rightarrow \bar{p}_{ri}$  ideal price index for the domestic Armington aggregator

 $+ \tau_i^* \geq 1$  iceberg cost  $\rightarrow$  control *trade openness* 

 $\rightarrow$  Dynastic framework with three stages: pre-education, education and working

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Value of a worker at age j in labor market  $\ell = (r,i)$ 

$$V_{j}(a, x, \ell, e) = \max_{c_{s}, c_{m}, a'} \left\{ U(c) + \mathbb{E} \left[ \max_{\ell'} \left\{ \epsilon_{\ell'} - \psi_{je}(\ell, \ell') + \beta V_{j+1}(a', x', \ell', e) \right\} \right] \right\}$$
$$q_{r}c + q^{a}a' \leq w_{e\ell}x\bar{h} + (1 + r^{*})q^{a}a, \qquad a' \geq \underline{a}_{j,e}$$

o consumption  $c = C(c_s, c_m)$ , price index  $q_r = Q(q_{rs}, q_{rm})$ .

- o  $\epsilon_{\ell'}$  realized and  $\ell'$  choice at end of period  $\rightarrow$  after c and a' chosen Key departure from ACM (2010), CDP (2019), etc.
- $\circ$  education e is fixed

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Value of college  ${\it e}={\it c}$  at age j=1,2

$$V_j(a, x, \ell, \boldsymbol{c}) = \max_{c_s, c_m, a'} \left\{ U(c) + \mathbb{E} \left[ \max_{\ell'} \left\{ \epsilon_{\ell'} - \psi_{je}(\ell, \ell') + \beta V_{j+1}(a', x', \ell', \boldsymbol{c}) \right\} \right] \right\}$$
$$q_r c + q^a a' + q_{rs} \kappa \leq w_{n\ell} x \frac{\bar{h}}{2} + (1 + r^*) q^a a, \qquad a' \geq \underline{a}_{j,c}$$

o  $\kappa$  cost college

- o work part-time and receive non-college wage
- o looser borrowing limit for college  $\underline{a}_{i,c}$

## **Newborns and Transfers**

- $\rightarrow$  Dynastic framework with three stages: pre-education, education and working
  - $+\,$  Value to a newborn who receives a transfer  $\Phi$

$$\mathcal{V}_0(\Phi, x_p, \ell_p, e_p) = \mathbb{E}\left[\max_e \left\{-\phi \mathbb{I}_{\{e=c\}} + \max_\ell \left\{\epsilon_\ell - \psi_0(\ell_p, \ell) + V_1(\Phi, \boldsymbol{x}, \ell, e)\right\}\right\}\right]$$

$$\label{eq:phi} \begin{split} \phi \sim F_e(e_p), \ x \sim F_x(x_p), \ \text{for parental states } (e_p, x_p). \end{split}$$
 (Abbott, Gallipoli, Meghir, and Violante, 2019), (Daruich, 2020)

+ Transfer at age  $j = J_k$  $\max_{\Phi \ge 0} \left\{ V_{J_k}(a - \Phi, x_p, \ell_p, e_p) + \hat{\beta} \mathcal{V}_0(\Phi, x_p, \ell_p, e_p) \right\}$ 

# **Education Policy**



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# Calibration

# Calibration - key nationwide parameters

o Household: period = 2 years,  $J_k = 15$ ,  $J_R = 25$ 

+  $\beta = 0.98 \rightarrow$  wealth/income  $\approx 3.5-4$ +  $\hat{\beta} = 0.85 \rightarrow$  transfer/income  $\approx 0.5$ 

- o College decision
  - +  $\kappa 
    ightarrow$  college pprox 36% of workers

$$+ \; \ln \phi \sim \mathcal{N}(m_{e_p}, \sigma^2)$$
, for  $e_p = c, m_{e_p}$ 

- inter-generational education persistence  $\approx 77\%$
- +  $\underline{a}_c \rightarrow$  borrow 50% of college (for 14 years)

Sector decision

+ 
$$\varepsilon_i \sim Gumbel(-\rho\gamma,\gamma)$$

 $+ \psi^u 
ightarrow$  annual sector persistence pprox 97%

(Artuc, Chaudhuri, and McLaren, 2010)

o Consumption bundle:

$$\begin{array}{l} + \ c = \left(\sum_{i} \nu_{i}^{\frac{1}{\rho}} c_{i}^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}} \\ + \ \rho = 0.5 \\ + \ \nu_{s} = 0.81 \text{ and } \nu_{m} = 0.19 \\ + \ \text{match} \ \text{aggregate} \ \text{labor} \\ \text{share by sector} \end{array}$$

#### + Three regions

- differ only in productivities,  $z_{rs}$  and  $z_{rm}$ , and factor intensities,  $\gamma_{rs}$  and  $\gamma_{rm}$
- + Match employment share + skill compensation by regions in 1990
  - West  $\rightarrow$  low exposure (low manufacturing labor share)
  - Midwest  $\rightarrow$  high exposure (high manufacturing labor share)
  - North-East  $\rightarrow$  mid exposure (average manufacturing labor share)
  - $\rightarrow\,$  choose  $z_{rs}$  and  $z_{rm}$  keeping income per-worker across regions approx constant
- + Choose domestic trade costs,  $au_{rmr'}$ , to match domestic trade shares (CFS for 1993)

# Modeling trade openness - nationwide

#### Main Exercise:

- At t=0 the economy is at a steady state with high  $\tau_m^*$ , and  $\tau_s^*$ 
  - + "Closed economy" calibrated to 1990
  - $+\,$  home-bias: services  $\approx$  98%, and manuf  $\approx$  90%
- o At t = 1,  $au_m^*$  unexpectedly decrease  $( au_s^*$  as well)
  - $+\,$  Large decline in the cost of importing manufacturing goods
  - + A sudden and permanent shock
  - $\ + \$  The economy slowly converges to the new steady-state
  - + "Open economy" calibrated to the 2010s  $\rightarrow$  manuf h-b  $\approx 75\%$

# The dynamic effects of trade openness

- 1. Cross-regional differences
- 2. Who goes to college more?
- 3. The welfare consequences of trade openness
- 4. Skill acquisition as margin of adjustment

### Real wages: winners and losers



- o Services expand and manufacturing contracts
- o Wages respond accordingly

### Real wages: winners and losers

con-

ac-



### Real wages: winners and losers



- Services expand and manufacturing con-
- o Wages respond accordingly
- Effect depends on exposure to the shock
- Persistent effects

# Wage premium increases ...



o Expansion in services leads to higher wage premium

# Wage premium increases ...



- o Expansion in services leads to higher wage premium
- Effect is larger for the highly exposed region

# Wage premium increases ...



- o Expansion in services leads to higher wage premium
- Effect is larger for the highly exposed region
- Larger increase on impact than in the longrun

#### ... and college enrollment increases as well



o Increased wage premium leads to higher college enrollment

#### ... and college enrollment increases as well



- o Increased wage premium leads to higher college enrollment
- Effect is larger for the highly exposed region

# **Cross-Regional Regression: model vs data**



o Model matches college enrollment regression

- 1. Cross-regional differences
- 2. Who goes to college more?
- 3. The welfare consequences of trade openness
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# Who goes to college more?



- College enrollment increases mostly in the high exposure region.
- As in data, the increase is concentrated in wealthy household.

# Who goes to college more?





# Who goes to college more?





# Large changes in transfers for households in manufacturing



- decline sharply in manufac-
- Explains the differential in college enroll-

# Large changes in transfers for households in manufacturing



- 1. Cross-regional differences
- 2. Who goes to college more?
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# Uneven welfare gains of trade

Consumption Equivalents by region



 Welfare gains: small for low-exposure large for high-exposure.

# Uneven welfare gains of trade



- Welfare gains: small for low-exposure large for high-exposure.
- Gains in high exposure region are very heterogeneous
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# Uneven welfare gains of trade

#### Consumption Equivalents by region



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Midwest Services 6 % from closed steady-state Δ -O-College - Impact -Non-College - Impact → College - After a generation -Non-College - After a generation -2 -4 -6 3 Wealth Quartile



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- o Gains in high exposure region are very heterogeneous
- Short run effects largely driven by sector.
- o Welfare differentials disappear after a generation



- 1. Cross-regional differences
- 2. Who goes to college more?
- 3. The welfare consequences of trade openness
- 4. Skill acquisition as margin of adjustment

 $\rightarrow$  Caveat: Focus on exposed region in extreme case of an "island" model

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- o Education is a type inherited from parents
  - + Constant over a life-time
  - + Still have to pay for college
  - + Parents choose transfers optimally
  - + Sectoral choice as before
- $\rightarrow\,$  education is not a margin of adjustment any more

# Fixed Education induces larger wage premium



- o Wage premium permanently higher
- Part of wage of premium comes form sectoral composition



# Welfare gains differences persist with Fixed Education



# Welfare gains differences persist with Fixed Education



# Welfare gains differences persist with Fixed Education



### Newborn's CEV with Endogenous and Fixed education

gain differentials lessen with endogenous education after a generation ...

- but they persist with fixed education.
- + For new generations. the redistributive effects of endogenous education are key on impact.

- o Trade openness has very different effects across regions
- o Services expand  $\rightarrow$  wage premium increases  $\rightarrow$  college enrollment increases + Effect concentrated in wealthier households and/or in services
- Welfare implications:
  - + Short-run: uneven gains and losses driven by region and sector
  - + Long-run: only gains, more even due to endogenous skill acquisiton

# Conclusions

#### **Conclusions:**

- o Evidence: trade shocks
  - + more detrimental for less educated workers
  - + increase college enrollment, especially for high-income families.
- o Model: Consistent with evidence.
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- Model:
  - $+\,$  Improve calibration: Target calibration to specific changes over time,...
  - + Fix bug in multi-region fixed education model
  - + Policy exercises: college subsidies,...

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# Thank you!!

# Appendix

# Measuring trade shocks – Autor, Dorn, & Hanson (2013)



# Effect on education by income level

College enrollment by income quartiles  $\beta^q$ 



# Effect on education by income level

College enrollment by income quartiles  $\beta^q$ : effect by sector



### Uneven Welfare gains of trade



 Workers with and without a college education gain on impact



## Uneven Welfare gains of trade



- Workers with and without a college education gain on impact
- o Poor households with a college education gain the most.

### Fixed Education induces larger wage premium



# Migration responds to trade shocks, only for the young

$\Delta y_{rt}$ : change in migration by age group		
	Age $18-25$	Age $30 - 55$
$\Delta IPW_{rt}$	$0.021^{***}$	0.001
	(0.01)	(0.01)

Notes: \*\*\* p < 1%, \*\* p < 5%, \*p < 10%

